Effects of deer overabundance on avian abundance, diversity, and reproductive success in Central Texas

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Introduction

White-tailed deer (*Odocoileus virginianus*) populations have dramatically increased in recent decades, resulting in ecological impacts ranging from alterations in vegetative composition to transmission of zoonotic diseases (reviewed in Côté et al. 2004). Extensive browsing of vegetation by deer can lead to cascading effects across many trophic levels including deleterious effects on insects, mammals and birds. Although many studies have examined the effects of overabundant deer populations on vegetation, relatively few studies have examined the effects on avian populations (Côté et al. 2004). The goal of this research is to analyze the effects of deer overabundance, and the associated over browsing of vegetation, on bird populations in central Texas.

The majority of work examining the effects of deer overabundance on birds has been conducted in the northeastern US where deer densities are at the highest levels seen this century (McCabe and McCabe 1997). These studies have shown a general decrease in avian abundance and/or diversity in association with deer overabundance and browsing (DeGraaf et al. 1991, deCalesta 1994, McShea and Rappole 2000). In addition, it has been suggested that higher deer densities may decrease avian reproductive success through modification of vegetative structure and composition (McShea and Rappole 2000) or through nest failure by direct predation (Pietz and Granfors 2000) or trampling (as has been shown with livestock; Pavel 2004). However, no research has examined the relationship between deer densities and avian nest survival.

In central Texas, deer densities are thought to be much higher than those that have historically occurred (Wolverton et al. 2007). Given the findings of research in other areas of the US, it would be expected that over browsing of vegetation would negatively affect local bird populations. Recent work conducted in central Texas has shown that deer browsing reduces seedling survival and growth of Texas red oak (*Quercus buckleyi;* Russell and Fowler 2004), a key component of many bird species' habitats. Birds may avoid areas of heavy browse entirely or, if they are present, have lowered reproductive success. The next step, and that which we undertake here, is to compare avian diversity, abundance and reproductive success between areas of high and low deer densities.

Understanding the effects of deer on avian abundance and survival is particularly important when dealing with bird species of conservation concern. The golden-cheeked warbler (*Dendroica chrysoparia*) and black-capped vireo (*Vireo atricapilla*), both federally endangered species, rely on oak species for foraging and nest placement. Deer overabundance and over browsing has been implicated as a threat to populations of both bird species (U.S. Fish and Wildlife Service 1991, 1992), yet no empirical work has been conducted to verify this relationship. In addition to providing novel tests of hypotheses regarding the relationship between deer densities and avian reproductive success, the results of this research could be used to identify management options to aid in the conservation of the two local endangered bird species.

Hypotheses/Predictions

H1: High deer densities and associated browsing alter the vegetation structure and composition in Central Texas.

P1: There will be decreased oak recruitment (saplings and seedlings) in areas with low deer density compared to areas with high deer density.

H2: Altered vegetation structure and composition as a result of deer browsing will affect avian abundance, diversity and/or reproductive success.

P1: Avian abundance and diversity will be lower in areas with low deer density compared to areas with high deer density.

P2: Birds will nest in areas of decreased browse or in unpalatable species.

P3: Birds will experience lowered reproductive success in areas with low deer density compared to areas with high deer density.

Methods

This study took place in Travis County, Texas, on sites with and without active deer management. The site with deer management is a privately-owned, 1800 acre ranch where, in 2007, deer populations were reduced from approximately 1 deer/4 ac to 1 deer/20 ac. The sites without deer management are the Long Canyon and Coldwater units of the Balcones Canyonland Preserve (BCP). Hunting is not permitted on either BCP unit and deer densities are estimated at approximately 1 deer/2.1 ac. Both sites have ongoing deer surveys to determine approximate deer densities. Work was conducted during the bird breeding seasons from April to July, 2010 and 2011.

We conducted vegetation assessments at a randomly selected subset of point count locations (see description below) and at all Northern Cardinal (*Cardinalis cardinalis*) nests. We chose to focus on cardinal nests because that was our most abundant species, they were found in a wide variety of habitats, and they often nest low in the canopy where the effect of deer browse should be strongest. Macro and microhabitat variables were recorded at all sites, following the protocols of BBIRD nest habitat assessment (Martin et al. 1997). We include a subset of these variables (Table 1), with an emphasis on those that would likely elucidate effects of deer browse. Habitat measurements were used to document vegetative differences between high and low deer density sites and to determine if birds were placing their nests in habitats non-randomly (e.g. in areas with less browse). Comparisons between high and low density deer sites as well as between nest locations and random locations were compared using MANOVA.

To estimate avian diversity and abundance, point counts were established across the entirety of the sites. Point count locations were placed a minimum of 100-150 m apart across a variety of habitat types. Bird species, mode of detection (song, call, visual or fly over), estimated distance and direction were recorded for all detections. Point counts were conducted three times during the breeding season, approximately once per month. Only detections less than 50 m from the point were used in analysis. Mean number of birds and bird species detected per point were compared between high and low density deer sites using t-tests and ANOVA.

Reproductive success was determined by finding and monitoring nests of all open cup nesting birds. In 2011, we focused our efforts on Northern Cardinals. Nests were found using behavioral cues, following the protocol of Martin and Geupel (1993). Nests were monitored every 2-4 days until fledge or failure. Daily nest survival was calculated for high and low density deer sites using Generalized Linear Models, as outlined by Shaffer (2004).

Results

We conducted habitat assessments at 61 random points and at 37 cardinal nests. At random sites, MANOVA analysis indicates that, overall, the habitats between the high deer density (BCP) and low deer density (ranch) sites differed ($F_{7, 52} = 6.85$, $P < 0.001$). As predicted, we found higher numbers of seedlings and saplings (< 8 cm dbh) on the ranch, where deer populations were reduced, compared to the BCP sites. There were over 5 times more deciduous seedlings/saplings on the ranch compared to the BCP (mean = 26.41 ± 8.11 and 5.13 ± 1.88; $F_{1, 59} = 7.15$, $P < 0.01$). We also detected more Ashe Juniper, large deciduous trees, and litter on the ranch (all $F > 7.19$, all $P < 0.01$). All other habitat variables were similar between sites (all $P > 0.11$).

When comparing random sites to Northern Cardinal nest sites within the treatments (as a measure of nest site selection), we found that the habitat around cardinal nests differed substantially from what was randomly available at BCP sites ($F_{7,41} = 9.62$, $P < 0.001$) but not at the ranch ($F_{7, 39} = 1.86$, $P = 0.10$). On the BCP, nests were in areas with more deciduous seedlings/saplings than random points (mean = 41.89 ± 8.98 and 5.13 ± 1.88; $F_{1, 47} = 30.52$, $P < 0.001$), indicating a preference for areas with deciduous regeneration.

We conducted point counts in late April, May and June in 2010 and in late May and June 2011. In total, 115 points were distributed across all sites (mean 19.17 ± 0.54 per site), although the number included in analyses was often reduced due to random noise disturbances. Contrary to our predictions, in each year, we detected more bird species ($t = 2.46$, $P = 0.01$ and $t = 6.39$, $P < 0.001$), and in 2010, significantly more individual birds ($t = 2.86$, $P < 0.01$), per point on the BCP compared to the ranch sites for our first round of counts (April 2010 and May 2011). However, the sites were very similar in all subsequent point count replicates for both years (all $P > 0.17$). We detected Golden-cheeked Warblers at both sites and during all replicates. Our highest detections of Golden-cheeked Warblers occurred during the May 2011 survey where we detected 13 warblers on BCP and 11 on the ranch. We did not detect any Black-capped Vireos on any site.

We found and monitored 55 nests from 8 species. Our most common species were Northern Cardinals (37 nests), Blue-grey Gnatcatchers (*Polioptila caerulea*; 8 nests), and Chuckwill's Widows (*Caprimulgus carolinensis*; 5 nests). We only had enough data to run nest survival analyses for Northern Cardinals. We found that nest survival was slightly lower on the BCP sites (model averaged estimate = -0.18) although the 95% confidence intervals encompassed zero (-1.01, 0.65), indicating a weak effect.

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Table 1. Habitat characteristics measured at random and nest sites in areas of high and low deer abundances. Modified from BBIRD field protocol (Martin et al. 1997).

Variable	Variable Description
CANHT	Height (m) of canopy
CANCOV	Canopy closure (%) at 4 cardinal directions in 5 m radius
LITTER	Litter depth (cm) at 4 cardinal directions in 1 m radius
JUNSTEM	Number of juniper stems (< 8 cm dbh) in 5 m radius
DECSTEM	Number of deciduous stems (< 8 cm dbh) in 5 m radius
JUNTREE	Number of juniper trees (≥ 8 cm dbh) in 11.3 m radius
DECTREE	Number of deciduous trees (≥ 8 cm dbh) in 11.3 m radius